

# FINAL REPORT

## Studies in Reliability Theory and Survival Analysis and in Markov Chain Monte Carlo Methods

AFOSR Grant No. F49620-96-1-0132

Hani Doss, Principal Investigator

Period May 1 1996 to September 30 1998

### Papers Published

1. Athreya, K.B., Doss, H. and Sethuraman, J. (1996). A Proof of convergence of the Markov chain simulation method. *The Annals of Statistics* 24, 69-100.
2. Doss, H. and MacEachern, S.N. (1997). The Dirichlet process. *Encyclopaedia of Mathematics*, suppl. vol. I, M. Hazewinkel, ed., 224-225, 1997, Kluwer Academic Publishers, Dordrecht.
3. Doss, H., Huffer, F. and Lawson, K. (1997). Bayesian nonparametric estimation via Gibbs sampling for coherent systems with redundancy. *The Annals of Statistics* 25, 1109-1139.
4. Doss, H. and Narasimhan, B. (1998). Dynamic display of changing posterior in Bayesian survival analysis. In *Practical Nonparametric and Semiparametric Bayesian Statistics*, D. Dey, P. Mueller, and D. Sinha, eds., 63-87, Springer-Verlag, New York.

### Technical Reports Issued

1. Li, S., Pearl, D.K., and Doss, H. (1996). Phylogenetic tree construction using Markov chain Monte Carlo.
2. Doss, H. and Narasimhan, B. (1998). Dynamic display of changing posterior in Bayesian survival analysis: The software.

### Other Activities

I was a member of the Joint Statistical Advisory Group at Stanford University (a group of researchers who study problems posed by the N.S.A.) led by Dr. James Maar of the N.S.A. and Professors David Siegmund and Art Owen of the Statistics Department at Stanford, for each of the three summers in the period under consideration. I

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wrote four technical memoranda on problems of interest to some anonymous parties in the D.o.D. and forwarded to us through Dr. Maar.

#### Invited Talks

1. Fifty-First Meeting of the Seminar on Bayesian Inference in Econometrics and Statistics, Ohio State University, May 1997. *Dynamically varying prior and posterior in Bayesian nonparametric analysis of censored data.*
2. Joint Statistical Meetings, Anaheim, California, August 1997. *Monte Carlo methods for Bayesian analysis of censored data using mixtures of Dirichlet priors.*
3. Michigan State University, Department of Statistics, November 1997. *Bayesian analysis of censored data using mixtures of Dirichlet priors.*
4. ENAR/IMS Spring Meeting, Pittsburgh, Pennsylvania March, 1998. *Reconstruction of phylogenetic trees via Markov chain Monte Carlo.*
5. International Conference in Reliability and Survival Analysis, Northern Illinois University, May 1998. *Dynamic visualization of changing prior and posterior in Bayesian nonparametric analysis of censored data.*
6. Joint Ohio State University, Cleveland Clinic Foundation, Case Western Reserve University Annual Biostatistics Minisymposium, Ohio State University, May 1998. *Dynamic visualization of changing prior and posterior in Bayesian nonparametric analysis of censored data.*

(Abstract)

The focus of the work has been the development of Markov chain "Monte Carlo" methods in Bayesian analysis, with emphasis on applications to survival or reliability data. We have emphasized the development of methods of dealing with analysis of sensitivity to the prior distribution.

In analyzing survival data coming from reliability studies, if we are interested in estimating the distribution of the lifelength of a component, we can use a nonparametric model or a parametric model. A nonparametric model will always give valid estimates, but these are considerably more variable than estimates from a parametric model. On the other hand, parametric models give estimates that may be bad if the model does not conform to the real-world situation. For parametric models, it is necessary to obtain Bayesian parameter estimates, and this can only be done with "Monte Carlo" simulation methods. We have simplified the standard "hyperparameter" method by introducing an importance sampling scheme; this reduces the Monte Carlo estimate to considering only one prior. An interactive parameter control environment was introduced. A detailed example has been worked out involving predictions made in an "interval censored" study on breast cancer and chemotherapy response. Estimates of the heavy-tailed treatment results have been encouraging.